Senior High School

Curriculum Guide

VOCATIONAL SERIES

Electricity 12
and
Electronics 22

(Interim Edition, September 1963)

Province of Alberta

Department of Education

CONTENTS

COURSE CREDIT VALUES

Electricity 12 . . . . . 5 credits

Electronics 22 . . . . . 15 credits

Electronics 32 . . . . . 15 or 20 credits

One credit corresponds to a minimum of 40 minutes of instruction time per week.

FOREWORD

In this age of missiles, rockets, satellites and space capsules, there seems to be little doubt that we have arrived at the threshold of conquering space. There have been few scientific achievements that have received the acclaim given to the recent advances in this field. Much of the success achieved was dependent upon success in a closely related field - the field of electronics.

Electronics has played and continues to play an ever increasing role in industry, particularly in the field of automation. More and more industries are employing electronic devices of one sort or another.

Although schools, colleges and industry are training more and more electronic technicians, the number of competent technicians is insufficient for the proper maintenance of newly developed electronic equipment. There is no doubt that many openings exist and will continue to develop in the future, for those who are interested in making a career of electronics.

GENERAL OBJECTIVES

1. To impart to the student a knowledge of the role that electricity and electronics play in industry today, and the opportunities that exist in this rapidly expanding field.

2. To equip the student with sufficient skill and knowledge such that he will be highly employable in the electrical or electronics field.

3. To provide the student with sufficient background such that on entering the apprenticeship program, he will be able to advance at an accelerated rate on the basis of his proven ability on the job.

4. To prepare a student to a degree of competency acceptable to the Institutes of Technology sufficient for entry into the second year of the Electronic Technology program.

GENERAL INFORMATION

1. Course Credit Values

Electricity 12 - 5 credits.
Electronics 22 - 15 credits.
Electronics 32 - 15 or 20 credits.

NOTE: Electricity 12 is also the prerequisite for Electricity 22.

2. Safety Program

Every shop must have an effective safety program. In the electronics shop particular attention must be given to the safety measures required in the industry: adequate guards; cleanliness of shop and personnel maintained at a high standard; students properly clothed for their work; etc. The shop organization must be such as to ensure stressing this very important phase of the shop program.

A good safety program features the following devices: regular, consistent and thorough instruction; constant vigilance and checking by the instructor; safety posters; student safety committee; adequate first aid equipment; instructor trained and up-to-date in first aid methods; dynamic color painting of machines and equipment; adequate working space about machines; safety

NOTE: Electronics 32 will be forwarded as soon as the outline has been prepared.

lines on floor around machines; routine report on accidents however minor; machines and tools in approved working condition; a safety conscious group of students and instructor.

3. Instructor's Records

The instructor should keep accurate records of:
(a) Student enrolment and attendance
(b) Student accounts
(c) Student work activity
(d) Theory covered
(e) Tests given
(f) Student achievement
(g) Up-to-date inventory of all equipment

4. Students' Records

Instructors should ensure that students develop and maintain a neat and accurate record of:
(a) Notes on theory
(b) Daily shop activities (time cards)

5. Enrolment

The maximum enrolment recommended for Electricity 12 is 20 students. The maximums for Electronics 22 and 32 are 15 students.

6. Guidance and Vocational Information

Instructors must assume responsibility in their own trade area to ensure that students and guidance officials are aware of the local situation. It is essential that instructors be active, interested and informed regarding the opportunities in their field.

NOTE: In order to permit students from an academic Grade X program to cross over into the vocational program at the Grade XI level, schools may combine the 12 and 22 courses into one course for a total of 20 credits. Where these courses are combined, it is recommended that students purchase the Grade XI text only.

It should be clearly understood that success in the fields of electricity and electronics is largely dependent upon the students ability in mathematics and science. Students possessing a "C" standing in these subjects generally should not be encouraged to register in these courses.

Whereas the Electricity 12 course is an exploratory course open to all Grade X students, Electronics 22 and 32 are definitely vocational and only those students who have displayed ability and aptitude for the program should be encouraged to continue. It is not in the best interests of the student to permit him to continue in a program which demands a large portion of his school time, and in which the instructor and/or guidance counsellor feel that he has little chance of success.

OBJECTIVES FOR ELECTRICITY 12

1. To provide exploratory experiences in the fields of electricity and electronics.

2. To acquaint students with the opportunities for employment in the electrical and electronics fields.

3. To provide the necessary background for Electricty 22 and Electronics 22.

TEXT: UNDERSTANDING ELECTRICITY AND ELECTRONICS by Buban and Schmitt, McGraw-Hill Book Company.

In addition students must purchase the following Laboratory Experiment Manuals:

	Author	Publisher
Basic Electricity	Paul B. Zbar and S. Schildkraut	McGraw-Hill
Laboratory Experiments, Direct Current Fundamentals	John R. Duff	Delmar

The following reference texts should be in the library:

Reference Texts

Basic Electronics - Basic Electricity, Direct Current Fundamentals	Bernard Grob Orla E. Loper	McGraw-Hill Delmar
Industrial Electricity Volume I, Direct Current (3rd Ed)	Chester L. Dawes	McGraw-Hill
Basic Electricity, Part I and Part II	Van Valkenburgh	The Technical Press
Electric Circuits and Machines, Third Edition	Eugene Lister	McGraw-Hill
Introduction to Electric Circuits	Herbert W. Jackson	Prentice-Hall

INSTRUCTIONS ON THE USE OF THE FOLLOWING OUTLINE

The course outline is divided into three columns designated: Basic Information, Operations and Projects and References. The first column refers to the essential knowledge required. The second column outlines the activities to be performed by the students in the laboratory or shop. The third column is a guide to assist the instructor in locating the topics in the text. It is intended that this column also be used to indicate the supplementary references other than the text, deemed necessary to fill in topics where the text is inadequate. Instructors are requested to insert references which they consider to be most suitable for the particular topics outlined. It would be desirable if instructors would also note the time spent on the various units. This information will be extremely valuable to the curriculum committee in revising this outline. We ask that instructors keep two copies of this guide, one which can be returned to the Department with the instructors' notations as mentioned above, and one for their own records.

The time for each unit is noted and should be adhered to as closely as possible to ensure coverage of the entire course. There will be overlapping of theory into the laboratory which will have the effect of increasing the actual time devoted to the unit. It is estimated that on the average, two hours will be required to complete each experiment.

Timetables should be arranged so that this amount of time is available in a block so that the experiments may be completed and thus free the equipment for use by the next class.

Instructors must emphasize correct technique, correct tools and the development of skill with basic hand tools.

SPECIAL NOTE TO INSTRUCTORS

Substitute V.O.M.'s for V.T.V.M.'s in all experiment from Zbar and Schildkraut up to # 24 where applicable.

REFERENCE CODE FOR THE ELECTRONICS COURSE

B/S - Understanding Electricity and Electronics - Buban & Schmitt

G - Basic Electronics - Grob

J - Introduction to Electric Circuits - Jackson

R.A.H. Radio Amateur's Handbook - American Radio Relay League

G/K - Applications of Electronics - Grob & Kiver

REFERENCES (code)

P - Perensky, Electronic Instrumentation, Prentice-Hall

U - Cathode Ray Tubes & Their Associated Circuits - U.S. Government Printing Office

US - Theory & Use of Electronic Test Equipment - U.S. Government Printing Office

S - Stout, Basic Electrical Measurements - Prentice-Hall

N - Notes, Southern Alberta Institute of Technology

NI - Notes to be provided by the instructor

ML - Marcus & Levy, Practical Radio Servicing, second edition, McGraw-Hill

Basic Information	Operations & Projects	References
Unit I - Opportunities in Electricity and Electronics - 4 hours (Recommend 2 hours in September, 2 hours in June)		
Engineers Technicians Related Fields - training, employment and future.	Familiarization tour of the laboratory or shop to acquaint the class with shop procedure and routine.	
Unit II - Basic Concepts of Electricity - 20 hours		
Electron theory of matter		B/S - 117
Static electricity	Duff, Exp. # 1	B/S - 118
Dynamic electricity		B/S - 121
Electromotive force		B/S - 123
Resistance and conductance	Duff, Exp. # 6	B/S - 132
Insulators and conductors	Duff, Exp. # 7	B/S - 127
Unit III - Sources of E.M. F. - 4 hours.		
Friction		B/S - 118
Chemical action		B/S - 208-215
Heat action		B/S - 231
Light action		B/S - 228
Pressure (piezo-electric effect)		B/S - 231
Mechanical		B/S - 231 B/S - 220-221
Unit IV - Basic D. C. Circuits - 25 hours		
Basic components of a D.C. circuit		
Series circuits	Z/S, Exp. # 8	B/S - 146
Parallel circuits	Duff, Exp. # 4, Z/S, Exp. #9	B/S - 147
Switches - types and their application		
Series - parallel circuits	Duff, Exp.# 5, Z/S, Exp. # 10	
Use and Care of Meters	Z/S, Exp. # 4, 5, 6	
Ohm's Law Kirchoff's Law	Duff, Exp. #2, 3, 8, Z/S, Exp. #7	B/S - 144-154
Voltage Dividers	Z/S, Exp. # 12, 13	

Basic Information	Operations & Projects	References
Unit V - Magnetism and Electromagnetism - 13 hours		
History of magnetism		
Natural and artificial magnets		
Magnetic poles		B/S - 164
Magnetic fields		B/S - 165
Laws of Attraction and Repulsion	Duff, Exp. #9a	
Magnetic field strength		B/S -171, 172
Magnetic field around a current-carrying conductor		B/S - 171
The solenoid and electromagnet		B/S - 173
Applications of electromagnets		
Unit VI - D.C. Measuring Instruments - 8 hours (introduction)		
The D'Arsonval Movement		B/S - 238
The D'Arsonval as a voltmeter	Z/S, Exp. 14	B/S - 240-241
The D'Arsonval as an ammeter	Z/S, Exp. 15	B/S - 239
V.O.M. and V.T.V.M.	Z/S, Exp. 17	B/S - 244
Measuring Resistance		
- voltmeter - ammeter method		
- ohmmeter	Z/S, Exp. 16	B/S - 242
- wheatstone bridge		
Wattmeter and Watthour meter		B/S - 252

ELECTRONICS 22 - 15 credits

	Title	Author	Publisher
Texts	BASIC ELECTRONICS	Bernard Grob	McGraw-Hill
	APPLICATIONS OF ELECTRONICS	Grob & Kiver	McGraw-Hill

The following laboratory manuals must be purchased by the students:

BASIC ELECTRICITY	Zbar & Schildkraut	McGraw-Hill

(This manual was purchased for Electricity 12 so that students should be in possession of this book already)

BASIC ELECTRONICS	Zbar & Schildkraut	McGraw-Hill
RADIO AMATEUR'S HANDBOOK	American Radio Relay League	
R.C.A. Tube Manual		

REFERENCES

The following references should be in the electronics library:

FUNDAMENTALS OF ELECTRONICS	E. Norman Lurch	Wiley (General Publishing Company)
DICTIONARY OF ELECTRONIC TERMS	Allied Radio	
INTRODUCTION TO ELECTRIC CIRCUITS	Jackson	Prentice-Hall
BASIC THEORY AND APPLICATION OF TRANSISTORS	U.S. Army - Superintendent of Documents, Washington, D.C.	

RAYTHION TUBE MANUALS or equivalent - 3 volumes
1. Entertainment tubes
2. Transistors
3. Transmitter tubes

RADIO COLLEGE OF CANADA Service Manuals (post 1950)

P - Perensky, ELECTRONIC INSTRUMENTATION, Prentice-Hall
U - CATHODE RAY TUBES & THEIR ASSOCIATED CIRCUITS - U.S. Government Printing Office
US - THEORY & USE OF ELECTRONIC TEST EQUIPMENT - U.S. Government Printing Office
S - Stout - BASIC ELECTRICAL MEASUREMENTS - Prentice-Hall
ML - Marcus & Levy - PRACTICAL RADIO SERVICING - second edition, McGraw-Hill

Basic Information	Operations & Projects	References
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Why study electronics		
Always be careful		
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Symbols & abbreviations		
Charts & tables		G-506-509
- frequency spectrum		J-4
- resistivity		R.A.H. - 17
- conversion factors		J - 41
- dielectric constants		J-220
- construction practices		
- vacuum tube data		Tube Manual
- semi-conductor data		Transistor Manual
Methods of communication		
History of communication		
Elementary wave theory		
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Positive & negative charge		G - 12
Law of electrostatics		G - 13
Elements		G - 11
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2. Current Meters Moving coil meters, introduction, Mechanics of D'Arsonval movement, motor systems, control systems, damping system Meter characteristics, internal resistance, sensitivity, accuracy and sources of errors Basic ammeter, shunt formual, types of shunts Multirange ammeters, multiple shunts, ring shunts Use and care of current meters		4½ hrs.	PP 15, 16 USP 16,17, 18 USP 9,10,11 USP 11 USP 16,17,18 PP 15 USP 20,21
3. Voltmeters Basic voltmeter, multirange voltmeter, separate multipliers, series multipliers. Loading effect of voltmeters, use and care of voltmeters.		1½ hr.	PP 14 USP 14, 15 PP 22, 23 USP 20
4. Conclusion of Meter Theory Measurement of internal resistance, temperature compensation		1½hr.	USP 11, 17 SP 418 N 1.15.26
5. A.C. Meters Low frequency A.C. meters, moving vane meters, A.C. conversion of D.C. meters, rectification, types of rectifiers, rectifier circuits, sources of error. Thermocouple.. Review of basic principles, temperature compensation of thermocouple.		1½hr.	PP 29,30,31,32 USP 30,31,32 USP.81, 83 N 1.15.29

Detailed Outline, Lectures	Operations & Projects	Approx. Time	References
6. Ohmmeters Series ohmmeter, shunt ohmmeter, potentiometer type ohmmeter, use and care of ohmmeter, the megger.		1½ hr.	P-pp. 18,19 US-pp. 34,35 36,37 N 1.15.15
7. Study of Commercial V.O.M.	The student is asked to design a V.O.M. having 2 D.C. voltmeter ranges, 2 A.C. voltmeter ranges, 2D.C. current ranges and one ohmmeter range. Homework time approx. 5 hours.	3 hrs.	US-pp.54,55,57,58 P-p.21 N 1.15.22
8. Vacuum Tube Voltmeters Introduction. Elementary V.T.V.M. Bridge type D.C.V.T.V.M. Introduction of A.C.V.T.V.M., Rectifier amplifier A.C.V.T.V.M., Amplifier rectifier A.C.V.T.V.M. RF Probes, Peak to peak probes, D.C. probes. Ohmmeterportion of electronic multimeter. Slide back V.T.V.M. Computation of input resistors for multirange V.T.V.M.		4½ hrs.	P-pp.121,122, 123,127, 128,129, 137,138, US-p. 49 P-p.130,131 N 1.15.35 US-p.44-45 P-pp.250-251
9. Term Examination		1 hr.	
10. D. C. Bridges Introduction of wheatstone bridge, mathematics of wheatstone bridge. Kelvin double bridge.		1½ hrs.	P-p.46 US-p.122 S-p.84

RECEIVER THEORY (PART I)

Basic Information	Operations & Projects	References
1. Principles of Receivers		
(a) The TRF amplifier		G.K. p.296-298
(b) Receiver characteristics		G.K. p.298,299
(c) The R.F. tuning circuit		G.K. p.299-302
(d) Tuning capacitors		G.K. p.302-304
(e) Multiple TRF stages		G.K. p.304-306
(f) R.F. selectivity		G.K. p.306,307
(g) Regeneration in R.F. amplifiers		G.K. p.307,308
(h) A.M. detectors	Z/S, Exp.#47	G.K. p.308-312
(i) Volume controls		G.K. p.312-315
(j) A TRF receiver		G.K. p.315-317
(k) B. supply line		G.K. p.317-319

Basic Information	Operations & Projects	References

2. The Superheterodyne Receiver

(a)	How the superheterodyne operates	Use demonstrator	G.K. p.322-325
(b)	Advantages	such as Philco or R.C.A.	G.K. p.325,326
(c)	Heterodyning		G.K. p.326-329
(d)	Effect of heterodyning on the signal		G.K. p.329,330
(e)	Converter circuits		G.K. p.330-334
(f)	Local oscillator	Z/S, Exp. #49	G.K. p.334-337
(g)	Spurious responses		G.K. p.337,338
(h)	I.F. amplifier		G.K. p.338,342
(i)	Automatic volume control		G.K. p.342-345
(j)	Typical receiver		G.K. p.348-352

TEXTS:

(1) Practical Radio Servicing by Marcus & Levy - McGraw-Hill

(2) Theory and Use of Electronic Test Equipment, published by U.S. Government Printing Office, Washington 25, D.C.

(3) Students will require the texts authorized for Electronics 22 in addition to the above.

LABORATORY MANUALS:

The following laboratory manuals must be purchased by the students:

(1) Basic Electronics by Zbar and Schildkraut, McGraw-Hill. (This manual was purchased for Electronics 22 so that it should be in the possession of the students now.)

(2) Basic Radio by Zbar and Schildkraut; McGraw-Hill.

REFERENCES:

The following references should be available in the library in addition to those previously listed.

CODE

G-T - Basic Television by Bernard Grob (3rd ed.) McGraw-Hill
G.K. - Applications of Electronics, Grob & Kiver, McGraw-Hill
M. L. - Practical Radio Servicing (First ed.), McGraw-Hill
R. C. A. - R. C. A. Receiving Tube Manual
R. A. H. - Radio Amateur's Handbook
N - Instructor's Notes

ELECTRONICS 32 UNITS AND SUGGESTED TIME:

1. Receiver Theory - 90 hours

2. Transmission Theory - 30 hours

3. Instrument Theory - 60 hours

4. Introduction to Television - 60 hours

LABORATORY EXPERIMENTS:

Jobs #47, 49, 50, from Z/S Basic Electronics.
Jobs #51 to 75 omitting 64, from Z/S Basic Radio. - 94 hours.

5. Radio Servicing - 36 hours

6. Instrument Laboratory - 10 hours

7. T. V. Servicing Laboratory - 20 hours

NOTE:

Schools wishing to offer Electronics 32 for 20 credits will have the choice of developing additional units based on the equipment available and the interest and ability of their students -

or

Devoting more time to the required course content to ensure a thorough understanding of the basis concepts.

The following suggestions are given for those instructors offering "32" for 20 credits, and who wish to cover more material:

(1) Complete as much material as possible in Basic Electronics by Bernard Grob.

(2) Develop more depth in F.M.

(3) Additional theory and servicing of T.V. receivers.

Basic Information	Operations & Projects	References
1. Frequency Modulation (Receivers)	Use demonstrator such as Philco or R.C.A.	
(a) The F. M. signal. Advantages and disadvantages.		G.K. p.216-222
(b) A.M. - F.M. receivers		G.K. p.373-379
(c) Limiters		G.K. p.379-382
(d) Detectors		
i. Ratio detector		RCA. p.43,44
ii. Gated beam detector	To be discussed in T.V.	G.K. p.384, 385
iii. Discriminators (note i and ii will be discussed more fully in T.V. theory)	Theory	RCA p.43, G.K. pp. 282-284
(e) Triple-tuned discriminator		G.K. p.382-384
(f) Phase shift discriminator		N.
(g) Automatic frequency control		N.
2. Preparing for Success in Troubleshooting		
(a) How you learn		M.L. p.2
(b) Troubleshooting		M.L. p.3
(c) Importance of test procedures		M.L. p.4,5
(d) Professional servicing procedures		M.L. p.5
(e) The customers complaint		M.L. p.5,6
(f) Asking questions		M.L. p.6,7
(g) Confirming the complaint	Z & S Job 59	M.L. p.7
(h) Looking for clues	Z & S Job 62	M.L. p.7,8
(i) Types of complaint		M.L. p.8
(j) The place of "Know How" and Experience		M.L. p.9,10
(k) Performing tests		M.L. p.10
(l) The air check		M.L. p.11
3. How the A. C. - D. C. Power Supply Operates		
(a) Heator supply for a 1-tube, 2-tube and 5-tube receivers	Z & S Job 60	M.L. p.28-30
(b) Position of tubes in the heater circuit		M.L. p.30,31
(c) The dial lamp		M.L. p.31
(d) How plate supply is connected to the output stage		M.L. p.31,32,37,38
(e) Additional filters		M.L. p.38-40
(f) Standard A. C. - D. C. power supply circuit		M.L. p.40,41
(g) Operation on a D. C. line		M.L. p.41,42
(h) Floating chassis		M.L. p.42
(i) Circuit of older A. C. - D. C. power supply		M.L. p.42,43
(j) Test points and tests	Z & S Job 61	M.L. p.43,44

Basic Information	Operation & Projects	References
4. Servicing the Heater Power Supply		
(a) Preliminary check		M.L. p. 47, 48.
(b) Tube socket tracing		M.L. p. 48, 49, 50
(c) Systematic checking		M.L. p. 51
(d) Ohmmeter checking		M.L. p. 51-60
(e) Voltmeter checks		M.L. p. 51-60
(f) Intermittents		M.L. p. 60,61
5. Servicing the Plate Power Supply		
(a) Rectifiers	Use demonstrator such	M.L. p. 62, 63
(b) Input Filter capacitors	as Philco, RCA or Welch	M.L. p. 64-71
(c) Output filter capacitors		M.L. p. 71-75
(d) Power supply short circuits	Z&S Job 64	M.L. p. 75
(e) Printed circuit tracing techniques	Refer to Jobs 34,35,36	M.L. p. 75-77
(f) Power supply variations		M.L. p. 83-102
6. Audio Frequency Amplifiers		
(a) Quick check of an audio amplifier		M.L. p. 129, 130
(b) Quick check with a volt ohmmeter		M.L. p. 130-134
(c) Voltage analysis of an amplifier		M.L. p. 141-143
(d) Ohmmeter analysis of an amplifier	Z&S Job 55	M.L. p. 143
(e) Checking Coupling circuits		M.L. p. 148-156
(f) Testing and repair of volume controls		M.L. p. 156-161
(g) Distortion		M.L. p. 161-166
(h) Hum		M.L. p. 166-167
(i) Variation in audio circuits	Z&S Job 56	M.L. p. 173-211
7. How to use a Signal Generator		
(Home Study Assignment)	Give a short quiz to check assignment	M.L. p. 212-223
8. Servicing I.F. and Detector Stages		
(a) Test points for preliminary checks	Z&S Job 51	M.L. p. 249-250
(b) Signal checks		M.L. p. 250, 251, 252
(c) Output meters; Standard output	Z&S Job 57	M.L. p. 252, 253
(d) Use of output meters		M.L. p. 253,254
(e) Voltage analysis		M.L. p. 257, 258
(f) Resistance analysis		M.L. p. 258-265
(g) I.F. transformers		M.L. p. 265-270
(h) Repair and replacement of transformers		M.L. p. 270-273
(i) A.V.C. circuits	Z&S Job 52	M.L. p. 273-275
(j) Alignment of I.F. stages		M.L. p. 275-280
(k) Variations in I.F. stages	Z&S Job 53	M.L. p. 280-288

Basic Information	Operations and Projects	References
9. Servicing Converters		
(a) Preliminary checking procedures		M.L. p.310,313
(b) Voltage analysis of converters	Z&S Job 54	M.L. p.313-315
(c) Resistance analysis of converters		M.L. p.313-315
(d) Converter and oscillator tubes		M.L. p.315
(e) Gang tuning capacitors		M.L. p.317-319
(f) Oscillator coils		M.L. p.319
(g) Variations in converter stages	Z&S Job 58	M.L. p.324-327
(h) R. F. stages		M.L. p.331-336
(i) Loop antennas		M.L. p.336-340
(j) Alignment of front end	Z&S Job 63	M.L. P.336
10. Servicing Transformer Type Power Supplies		
(a) Preliminary checks		M.L. p.348
(b) Servicing heater supply	Refer Z&S Job 34,35,36	M.L. p.349,350
(c) Procedure for checking shorts		M.L. p.350,351
(d) Hum, squeals and motor boating		M.L. p.352
(e) Typical power supplies		M.L. p.355-359
(f) Variations in power supplies		M.L. p.359-363
11. Servicing Transistor Portables		
(a) Transistor amplifiers	Use demonstrator such	M.L. p.364-368
(b) Circuit characteristics	as Philco or RCA	M.L. p.368,369
(c) Bias		M.L. p.369-371
(d) Stabilizing circuits		M.L. p.371,372,373
(e) Temperature sensitive elements		M.L. p.373
(f) Signal feedback		M.L. p.374
(g) Basic transistor receivers		M.L. p.375-378
(h) Audio power amplifiers		M.L. p.379;380
(i) General servicing procedure	Z&S Job 75	M.L. p.380,381
(j) Power supplies		M.L. p.381-383
(k) Signal tracing methods		M.L. p.383,384
(l) Voltage analysis	Z&S Job 74	M.L. p.384,385
(m) Servicing techniques		M.L. p.385,386
(n) Transistor testing		M.L. p.387,388
(o) Alignment	Z&S Job 73	M.L. p.388,389
(p) Practical circuits		M.L. p.389-398

Basic Information	Operations & Projects	References
12. Servicing Auto Radios		
(a) Types of auto radios	Z&S Job 65	M.L. p.399
(b) Hybrid auto radios		M.L. p.399-403
(c) Input circuits		M.L. p.403,404
(d) Transistor output section		M.L. p.404,405
(e) Power supplies		M.L. p.406,407
(f) Trouble shooting procedures		M.L. p.407-410
(g) Alignment		M.L. p.410-412
(h) Auto noise suppression		M.L. p.412-414
(i) Circuit variations		M.L. p.414-422
(j) Vibrator circuits		M.L. p.422,423
13. Servicing F.M. Radios		
(a) The RF Stage (READ)		M.L. p.430,432,459,460
(b) Types of RF Tuners (READ)		M.L. p. 432
(c) Frequency Conversion (READ)		M.L. p.433,458
(d) Automatic Frequency Control (READ)		M.L. 434,436
(e) The IF Amplifier (READ)		M.L. 436,438,456
(f) The Limiter (READ)		M.L. 437,455,456
(g) The Discriminator (READ)		M.L. 438
(h) Tuning Guide (READ)		M.L. 439,441
(i) AF Section (READ)		M.L. 441
(j) FM Receiving Antenna (READ)		M.L. 441, 442, 460
(k) Combined AM/FM Receiver (READ)		M.L. 443
(l) Servicing the AM/FM Receiver (READ)		M.L. 444
(m) Approach to AM/FM Servicing		M.L. 444,446
(n) Quick FM Stage Check		M.L. 446,448
(o) FM Servicing Procedure		M.L. 449
(p) AM/FM Receiver Power Supply (READ)	Z&S Job 68	M.L. 449,451
(q) AM/FM Audio Section (READ)		M.L. 451
(r) FM Detector		M.L. 451,452
(s) Multiplex Operation (READ)		M.L. 453
(t) Multiplex Signals (READ)		M.L. 454
(u) How the Multiplex Adapter works-This portion should (READ)	receive close attention	M.L. 455
NOTE: FM Multiplex will be covered in more technical detail in Audio Theory.		
(v) The FM Antenna		M.L. 460,N.

Basic Information		Operations & Projects	References
(w)	Checking Voltages		M.L.,p460,462
(x)	Tracing Unwanted Oscillations		M.L. p.462
(y)	Switch Troubles		M.L. p.463
(z)	Replacement Precautions		M.L. p.463
(aa)	Common troubles in FM Sets	Z&S Job 70	M.L. p.463
(ab)	Alignment of FM Receivers	Z&S Job 71	M.L.p.463,465
(ac)	Location of Alignment Adjustments		M.L. p.465,466
(ad)	Methods		M.L. p.467
(ae)	Meter Method		M.L. p.467,468
(af)	Limiter-discriminator type - IF Alignment	Z&S Job 69	M.L. p.469,472, 480,483.
(ag)	Oscillator and RF Alignment		M.L. p. 472,473, 475,476
(ah)	Visual Alignment		M.L. p.476
(ai)	The Sweep Generator		M.L. p.476,477
(aj)	Oscilloscope		M.L. p.477,479
(ak)	Setting up		M.L. p.479,480
(al)	Ratio Detector type - IF Alignment		M.L. p.473,475, 483,484
(am)	Aligning the Multiplex Section		M.L. 484
14.	Servicing Dead Receivers		
(a)	Servicing Procedure	Z&S Job 72	M.L. p.487,488
(b)	Check for Visible Clues		M.L. p.488,490, 502
(c)	Phone or Volume Control Test	General Servicing of receivers	M.L. p.490
(d)	Tuning Eye or A.V.C. Test		M.L. p.490,491
(e)	Shock Tests		M.L. p.491,492
(f)	Use of Signal Generator		M.L. p.492;498, 500,504
(g)	Stage by Stage Check with sig. gen.		M.L. p.498
(h)	Oscillator Mixer Checks		M.L. p.499

Basic Information	Operations & Projects	References
15. Servicing Weak Receivers		
(a) Analysis of Complaint	During the portion of this course it is advisable to have the students service radios with typical faults placed in the receivers.	M.L. p.510
(b) Localizing fault to one stage		M.L. p.511
(c) Basic causes of weak receivers		M.L. p.512,513,514,515,516
(d) Gain measurements		M.L. p.516,517,518
(e) Checking for Misalignment		M.L. p.520,521,522
16. Hum Troubles		
(a) Analysis of Complaint	Servicing	M.L. p.523
(b) Basic Causes of Hum		M.L. p.523
(c) Identification of Types of Hum		M.L. p.524
(d) Localization of Hum		M.L. p.524
(e) Hum in B Supply		M.L. p.525,526,527
(f) Hum due to Heater Cathode Leakage		M.L. p.528
(g) Induced Hum		M.L. p.529
(h) Other causes of Hum		M.L. p.530,531, 533,534, 535,536
17. Oscillation and Motorboating		
(a) Analysis of Complaint	Servicing	M.L. p.538
(b) Compare Amplifier/Oscillator		M.L. p.538,539
(c) Oscillation in Screen Grid Circuits		M.L. 539,540
(d) Trouble in Decoupling Circuits		M.L. 541
(e) Trouble in Bypass Circuits		M.L. p.541,542
(f) Feedback due to lead dress and contacts		M.L. p.543
(g) Instability and Feedback		M.L. p.543,544
(h) Localizing Complaints		M.L. p.545,546, 547
(i) Microphonic Components		M.L. p.547
(j) Shielding		M.L. p.548,549
18. Noise and Interference		
(a) Causes of Noise	Servicing	M.L. p.552
(b) Noise Isolating Techniques		M.L. p.553
(c) Noise in Antenna and Ground System		M.L. p.554,555
(d) Noise within the Receiver		M.L. p.556,557, 558

Basic Information	Operations & Projects	References
(e) Isolating Noisy Stage		M.L. 559,560,561
(f) Locating Faulty Component		M.L.p.562
(g) Identifying External Noise		M.L. p.563,564
(h) Locating Source with a Portable		M.L. P.568
(i) Suppressing Commutator Noise		M.L. p.571
(j) Neon Sign and Lamp Noise		M.L. p.572,573
(k) Line Filters		M.L. p.575,576
19. Intermittents		
(a) Analysis of Complaint	Servicing	M.L. p.578,579
(b) Defects which can cause Intermittents		M.L. p.580
(c) Internal and External Causes		M.L. p.580
(d) Vacuum Tubes and Sockets		M.L. p.581,582
(e) Intermittents in Other Components		M.L. P.582,583
(f) Auto Radio Intermittents		M.L. p.583
(g) Intermittent Oscillators		M.L. p.584
(h) Techniques for Dealing with Intermittents		M.L. p.585,586, 587,588, 589.
20. Distortion		
(a) Definition of Distortion	Servicing	M.L. p.590,591, 592
(b) Types of Distortion		M.L. p.592
(c) Causes of Distortion		M.L. p.592,594
(d) Grid Bias; Grid Emission		M.L. p.592,595, 596
(e) Causes of Incorrect Bias		M.L. p.592,595
(f) Overloading		M.L. p.598
(g) Push-Pull Amplifiers and Phase Inverters		M.L. p.599,600
(h) Loudspeakers		M.L. p.601,602
(i) Localizing to Stage		M.L. 606
(j) Isolating Faulty Components		M.L. 607
21. The Communications Receiver		
(a) General	Z&S Job 66	ARRL p.86-141
(b) Tunable Front End		ARRL p.92,93. 165

Basic Information	Operations and Projects	References
(c) Tunable IF		ARRL p.98,99 N.
(d) Continuously Tunable		N.
(e) Sensitivity		
1. RF and IF Gain		ARRL p.112,110
2. Antenna Trimmer		ARRL p.93
3. AVC and Delayed AVC		ARRL p.101
(f) Selectivity	Z&S Job 67	
1. Crystal Calibrators		ARRL p.521 N.
2. Double and Triple Conversion		ARRL p.94,133, N.
3. Bandspread Tuning		ARRL p.92
4. Filters and multipliers		ARRL p. 50,51,106 107,141
(g) Stability		
1. Crystal and Permeability Oscillators		ARRL p.142,143,144
2. Regulated Power Supplies		N.
3. Construction		
(h) Detectors		
1. AM Detectors		ARRL p.86 to 90
2. CW and SSB Detectors		ARRL p. 90,91
3. The BFO		ARRL p.100,101
(i) Noise Limiters		ARRL p.102,103,104
1. Squelch Circuits		ARRL p.102,103
(j) Carrier Level Indicators		ARRL p.104
(k) Audio Outputs		
1. Loudspeaker		ARRL p.105
2. Headphones		ARRL p.105
3. Line		ARRL N.
(l) Quality of Components and General Construction		ARRL p.167,169, N.

Basic Information	Operations & Projects	References
1. Introduction		
(a) Transmitter requirements		G.K. Ch.7,Sec.1
(b) Types of waves		
(c) Need for radio communications		
(d) Licensing regulations		
2. Transmitter Circuits		
(a) Types of emission		AR p.15,59,69
(b) LC Oscillators (review T1, Secs. 5-1 to 5-8)		GK Ch.5,Sec.1-8
(c) Crystal Oscillators		GK Ch.5, Sec.9
(d) Power Oscillator		AR p.142,143,144
(e) RF Stages in transmitters		N.
(f) RF Power Amplifier circuits	It is recommended that	
1. Classification	instructors obtain a set	N.
2. Operating Angle	of notes in Transmission	N.
3. Efficiency	Theory from the SAIT to	N.
4. Power Gain	form the basis for this	N.
5. Plate dissipation	section.	N.
6. Power Output		N.
7. DC Power Input		N.
8. Action of Class C. Amplifiers		N. AR p.67
9. Distortion and Harmonic Content		N. AR p.63,64
10. Class B. linear amplifier		N. AR p.64,65,66
11. Action of Class B. linear amplifier		N.
12. Action of the LC Tank circuit		N.
13. Design of a parallel tank circuit		N.
14. Design of a pi-tank circuit		AR p.149,150,162
(g) Neutralization circuits		AR p.151,158,159.
(h) Neutralization procedures		AR p.403
(i) Frequency multipliers		AR p.142,164,425
(j) Interstage coupling and driving power	Demonstration of tuning procedures desirable at this point although not essential.	AR p.156,157
(k) Metering and tuning		AR p.164,165

Basic Information	Operations & Projects	References
(l) Keying methods		AR p.246 N.
(m) Parasitics		AR p.159,160
(n) Transmitting tubes		
(o) Power Supplies for transmitters		AR p.209,231-241
3. Modulation and Transmitters		
(a) Principles of modulation		
(b) Percentage of modulation		N.
(c) Sidebands		N.
(d) Methods of modulation		N.
(e) High and Low level modulation		N.
(f) AM Transmitters		N.
(g) Single Sideband Suppressed Carrier		N.
1. The filter system		N.
2. Balanced modulator		N.
3. The filter		N.
4. Heterodyning		N.
5. The phasing system		N.
(h) Frequency modulation		AR p.331-426
(i) Phase modulation		
(j) Frequency allocation		AR 13,14
4. Power Supplies		
(a) Sources of power for transmitters	The instructor should assign this section as home study with a follow-up classroom discussion.	Reading in GK, AR, RCA
(b) Transformers		
(c) The rectifier		
(d) The filter		
(e) Filter resonance		
(f) Filter component ratings		
(g) Power drain		
(h) Contactors and relays		
(i) Protective control circuits		
5. Antennae and Transmission Lines		
(a) Electromagnetic waves	The instructor should assign this section as home study with a follow-up classroom discussion	Reading in GK and AR
(b) Principles of radiation		

Basic Information	Operations and Projects	References

(c) Antenna requirements
(d) The dipole antenna
(e) Hertz and Marconi antennae
(f) Antenna types
(g) Directional arrays
(h) Radio wave propagation
(i) Transmission lines
(j) Feeding and matching antennae

UNIT THREE
INSTRUMENT THEORY

(60 Hours)

Basic Information	Operations & Projects	Approx. Time	References
1. Review--Sections 1 to 10 inclusive on METERS (Electronics 22)		4 hours	
2. A. C. Bridges General bridge equation. Capacitance and inductance comparison bridges. Maxwell bridge, mathematics of Maxwell bridge. Hay bridge. Comparison of Maxwell and Hay bridges.		5 hours	PP 72, 73, 74, 75, 77 USP. 125,126,128
3. Measurement of Inductance and Capacitance Measurement of C., substitution, time constant and frequency methods. Measurement of L., substitution, time constant and frequency methods. Q meter.		5 hours	 USP.124,128 USP.125 N 1 USP 140
4. Test Oscillators Review of basic Oscillator thoery Types of oscillators		2 hours	USP.94,95 96 N 1
5. Audio Frequency Generators Various types of A.F. Oscillators, transformer type, phase shift oscillator, wein bridge oscillator. Commercial A.F. Generator - analysis of a typical circuit. Beat frequency oscillatory Block diagram of B.F.O.		6 hours	 PP. 259,263 110 PP. 263 N 1
6. R.F. Generators Review of Armstrong Colpitts and Hartley circuits. Crystal oscillators. Various types of R. F. Generators - A.M., C.W., F.M. The grid dip oscillatory. Study of a commercial R.F. Generator. Frequency measurement, heterodyne method.		7 hours	 PP. 107 PP. 274-284 US P. 99,100 101 N 1.15.31
7. Sweep Generators Review of F.M. Generators. Study of sweep motor used in commercial units.		3 hours	US p.100,10 PP. 283,284
8. Signal Tracers		2 hours	US P. 143
9. Tube Testers Filament continuity, short testing, emission tests, gas tests, heater to cathode leakage test. Mutual conductance measurement.	Note: Some or all of this section may be given as homework depending on the time available.	4 hrs.	 US P. 65-76 P P.288-300 N I

Detailed Outline, Lectures	Operations and Projects	Approx. Time	References
10. Cathode Ray Tubes Electric fields, equipotential points and lines. The path of an electron moving through an electric field, fluorescence electrostatic focusing. Gun arrangement, optical analogy. Brightness and focus controls. Intensifier anode, spot size, radius of curvature. Electrostatic deflection. deflection. Deflection of an electron between charged parallel plates.	Lab demonstration using electromagnetic and electrostatic deflection.	7 hours	U P 1 to 25 P P 215-221
Angle of deflection. Deflection sensitivity. Position of deflection plates in a C.R.T. Advantage of linear sweep.			U P 26 U P 27
11. Oscilloscopes. The basic scope, the time base generator. Relaxation oscillator. Thyracron oscillator and sweep generator. Other types of sweep oscillators. Synchronization of sweep circuits. Vertical amplifiers, requirements of vertical ampls. Vertical ampl. circuits. Paraphase amplifiers - push pull deflection. Study of a typical commercial oscilloscope.		7 hours	P P 224,225 U P 66-75 U P 76 - 84 U P 111-129 N I
12. Frequency and Phase Measurements with the 'Scope' Lissajous figures, Phase measurement.	(Lab Job Z&S #50)	2 hours	P P 224 U P 195-199
13. Transistor Testing		6 hours	P P 299,300, 301
Quick Check (Ohmmeter)			P P 302,303,
In-Circuit Check (Audio Freq. Method)			P.P. 306,307 (304
Short Circuit Test			P P 307,310
Collector to Base Reverse Current I_{cbo}			P P 308,309
Grain Test			P P 310,311
Rin Test			P P 311,312
Dynamic Beta			

UNIT FOUR - INTRODUCTION TO TELEVISION - 60 HOURS

Basic Information	Operations & Projects	References
1. The Television System		
a. Picture Elements		G-T P. 1
b. Transmitting & receiving picture information.		G-T P.2-6
c. Scanning		G-T P.6-7
d. Motion Pictures		G-T P.7-8
e. Frame & Field Frequencies		G-T P.8-9
f. Vertical & horizontal scan frequencies		G-T P.9-10
g. Synchronization		G-T P.10
h. Picture quality		G-T P.10-12
i. Television channels		G-T P.13
j. The FM sound system		G-T P.14
k. Color TV principle		G-T P.14
l. Transmission standards		G-T P.15
2. Camera Tubes		
a. Photoemission		G-T P.18-21
b. Flying spot camera		G-T P.22-24
c. Types of camera tubes		G-T P.24-35
d. Closed circuit TV		G-T P.35
3. Scanning & Synchronizing		
a. Sawtooth waveform scanning		G-T P.38
b. Standard scanning pattern (include sample pattern)		G-T P.40
c. Flicker		G-T P.44
d. Raster Distortion		G-T P.45
e. Synchronizing pulses		G-T P.47
4. Composite Video Signal		
a. Construction		G-T P.52-57
b. Picture information		G-T P.58-61
c. Maximum number of picture elements		G-T P.62-64
d. Test pattern		G-T P.64-66
e. DC component of video signal		G-T P.66
f. Gamma		G-T P.68
5. Picture Carrier Signal		
a. Negative transmission		G-T P.73
b. Vestigial sideband		G-T P.74
c. The TV channel		G-T P.78-83
d. Line of sight transmission		G-T P.83-86
e. TV broadcasting		G-T P.86-91

Basic Information	Operations and Projects	References

6. Television Receiver

a.	Receiver circuits	G-T P. 94-1
b.	Sound takeoff	G-T P. 99
c.	Functions of receiver circuits *(Note #1)	G-T P. 101
d.	Operating controls	G-T P.103-104
e.	Localizing troubles	G-T P.112-115

* NOTE # 1 - Laboratory experiments 1, 2 & 3, Basic Television by Zbar and Schildkraut should be carried out mainly with the intent of teaching familiarization and proper safety procedures. The instructor may cover more experiments; however, this will be determined by the time and equipment that is available.